9 April 1963

STATINTL

Subject:

Proposal for Supplement to

STATINTL

Enclosure:

(1) Technical Proposal Supplement to five copies

STATINTL STATINTL

(2) Detailed Cost Analysis - five copies

Gentlemen:

is pleased to submit a quotation

STATINTL

for lacorporation in the current contract.

The total CPFF price for this improvement program is

payment terms Net 30 days. This quotation is
to be considered valid until 30 June 1963, after which time we
reserve the right to submit a revised cost estimate. Effort on
this supplement will be integrated into the basic program work.

An additional two months will be required to complete the basic
contract work because of long lead procurement items in this
supplement. However, every effort will be made to reduce the
procurement time on these items and the end item will be
delivered as early as possible. Terms and conditions of this
supplement are considered to be the same as those in the basic
contract.

STATINTL STATINTL

Engineering information is contained in

enclosed.

STATINTL

If further information is required, please contact the undersigned

by calling

STATINTL

DAM/mlk

STATINTL

Declass Review by NIMA / DoD

STATINTL

STATINTL



RECOMMENDED DESIGN CHANGES FOR
RESOLUTION IMPROVEMENT TO CHANGE DETECTOR

9 April 1963

STATINTL

STATINTL

TABLE OF CONTENTS

Section	Title	Pag
I	GENERAL	1
II	RESOLUTION CONSIDERATIONS	2
	1. CATHODE RAY TUBE	2
	2. HIGH VOLTAGE POWER SUPPLY	3
	3. DYNAMIC FOCUS	14
	4. OPTICS AND REGISTRATION CONSIDERATIONS	5
III	RASTER LINE SUPPRESSION	7
IV	CONSLUSIONS	9
V	WORK STATEMENT	10

SECTION I - GENERAL

This report covers the results of study conducted to determine the feasibility of increasing the read-out resolution of the change detector currently under development. In order to determine the requirements on the various components of the system affected by a resolution increase, a design goal of 50 optical line pairs per millimeter (100 TV lines per millimeter) referred to the film planes has been established. The present design goal is 20 optical line pairs per millimeter (40 TV lines per millimeter). The following areas have been included in the resolution study: the cathode ray tube, power supply regulation and ripple requirements, dynamic focus requirements, optical focus requirements, and registration accuracy. In addition, methods for eliminating the raster lines from the faces of the display tubes in the monitors have been considered.

1. CATHODE RAY TUBE

Assuming that the rest of the system is adequate, the method employed to achieve the maximum read-out resolution is to reduce the crt raster size until the lines just begin to overlap. The maximum read-out resolution obtainable is, therefore, inversely proportional to the spot diameter of the crt. A smaller spot diameter enables the raster to be shrunk in size, which results in higher read-out resolution. With the .0015 inch spot diameter tube installed in the breadboard system, a maximum resolution of 22 optical line pairs per millimeter referred to the film is obtainable. The recently received .001 inch spot diameter tube gives a read-out resolution of 30 optical line pairs per millimeter. This data from the existing tubes enables the spot diameter required to meet the 50 optical line pairs per millimeter design goal to be calculated at .00065 inches. Several 5 inch tubes with .0006 inch spot dismeters are available from different manufacturers. Although these tubes are developmental types, it is felt that they are sufficiently rugged and reliable for use in this system.

To fully realize the 50 optical line pairs per millimeter design goal, the raster size must be reduced to .3 inches (525 TV lines x .0006 in/TV line) in the vertical dimension and because of the 3 by 4 aspect ratio of the scanning system, .4 inches in the horizontal dimension. Assuming

unity magnification in the optical system a .3 inch by .4 inch area will be scanned on the 70 millimeter film planes. The "blow-up" or area enlargement under this condition is obtained by dividing the .5 inch diagonal measurement of the raster into the 14 inch diagonal measurement of the monitor tubes. The 28X area enlargement thus calculated is the point at which maximum resolution occurs. Further area enlargement to 40X is obtainable, however, no further increase in resolution will be available.

2. HIGH VOLTAGE POWER SUPPLY

One of the requirements that must be met to insure that the .0006 inch spot remains constant is that minimal ripple or other disturbances appear on the high voltage supply as the spot is deflected into a raster.

The deflection sensitivity of a crt (the distance the spot will deflect when a given deflecton field is applied by the yoke) varies inversely with the square root of the accelerating voltage. Any disturbances in the accelerating voltage will cause a change in the deflection sensitivity of the tube which will result in an undesired motion of the spot. Calculations have determined that if a maximum "wiggle" of 10 percent of the .0006 inch spot is permitted, a variation of \pm .5 volts of the 15,000 volt accelerating voltage for this tube can be tolerated. Several high voltage power supply manufacturers have been contacted to ascertain the feasibility of such a supply. Discussions with these manufacturers have

determined that a power supply with these regulations and ripple characteristics is within the state-of-the-art and can be built.

Variations in the focus voltage for an undeflected spot also affect the spot diameter adversely. The method currently employed to obtain the focus voltage by dividing down from the high voltage supply will be adequate to prevent defocusing of the spot as long as the voltage tolerance for the high voltage supply is maintained.

3. DYNAMIC FOCUS

Flat face cathode ray tubes require a variation in the focus voltage (dynamic focus) as the spot is deflected out from the center of the tube in order to maintain uniformity in the spot size. Dynamic focus affects the system resolution most when the raster is shrunk down to a small size and is positioned at different points to observe "blow-ups" of various areas of the films. The dynamic focus requirement for the present design which utilizes the .001 inch spot diameter tube are not as severe as that for a .0006 inch spot. For example, only the raster position information is needed to adequately retain the resolution capabilities in the present design. To meet a 50 optical line pair per millimeter design goal, however, both raster position and raster amplitude information must be used for dynamic focus on the .0006 inch spot tube. Raster position information only focuses the spot accurately at the center of the raster. When the amplitude of the raster is also included in the dynamic focus, the entire raster will always be correctly in focus. Circuitry to add the raster position and raster amplitude information must be developed to provide the dynamic focus capability.

4. OPTICS AND REGISTRATION CONSIDERATIONS

As the increase of resolution is obtained by reducing the spot diameter of the crt, the positioning of the elements involved in the imaging of the spot on the transparencies becomes proportionally more critical. The disturbances of the difference scene caused by lens distortions such as barrel, pincushion and keystone will become more evident with an improvement in the "acuity" of the system. The rigidity of the supporting mechanical elements must be increased to reduce the deflections due to their individual loadings to a value compatible with the more stringent requirements. The tightness of the joints and couplings of the mechanical linkages require upgrading. The fidelity of the motions associated with the optical formulae for positioning such as the magnification linkage and the X,Y position mechanism is also affected. The resolution of the servo position potenticmeters must improve. The threshold of the servo must be reduced. The losses in resolution due to mirror quality in the azimuth deflection dove mirror system and prism quality in the nutation assembly require reviewing.

Since the improved resolution will be used to identify the nature of a change after a difference has been detected, a means of optimizing the focus when viewing a reduced area of one channel will be required. To accomplish this a vernier positioning of the lens or film plane would be required.

To implement the vernier focusing of the magazine, the servo machine that positions the magazine as a function of the magnification linkage, will be upgraded. The nulling servo must be improved in accuracy and resolution. This will be accomplished by building a more precise mechanism and redesigning the position servo with higher resolution potenticmeters for servo position pick-off. The vernier will be a blasing potentiometer located on the control panel. This vernier will be capable of driving the magazine through the focus range of the lenses.

The spread function of the rotating dove mirror system will be improved by a more precise mirror mount with flatter and more rigid mirrors. Also the optical flatness and glass quality of the nutation prisms will be more rigorously controlled.

SECTION III - RASTER LINE SUPPRESSION

Due to the operator's proximity to the monitors when the console is in use, the raster lines on the monitor crt's will be clearly visible in the present system. It is extremely difficult in this type of scanning system to make the raster less objectionable by increasing the number of lines in the raster. Speeding up the horizontal scanning rate to increase the number of lines creates technical problems in the system due to phosphor persistence of the scanning tube, increased video bandwidth requirements, increased deflection system requirements, and requirements for a special monitor design. A lowering of the vertical frame rate introduces a flicker in the scenes viewed on the monitors which is undesirable for real-time viewing.

A method is available which will suppress the raster lines from the monitor screens without affecting the system resolution. If the spot on the monitor crt's is deflected at a very high rate (15 megacycles or greater) in the vertical direction an amount equal to the distance between the lines in the raster, no raster lines will be visible. This method commonly called "spot wobble" has been used effectively in television systems where close viewing of the monitor tubes is required. Special 14 inch monitor tubes can be built which are interchangeable with the existing monitor tubes with the

SECTION III - RASTER LINE SUPPRESSION

exception that a set of electrostatic vertical deflection plates will be incorporated. These deflection plates coupled to oscillator circuitry to generate a 15 megacycle deflection signal will provide the necessary spot wobble for raster line suppression.

SECTION IV - CONCLUSIONS

It is felt that with some design modifications and component changes, a resolution design goal of 50 optical line pairs per millimeter as measured by a standard USAF test target is feasible. The increase in resolution can be accomplished by scanning a smaller area of the film than the present design with a .0006 inch spot diameter cathode ray tube. To fully utilize the higher resolution capabilities of this tube, the high voltage and focus supplies must be designed to a tighter tolerance. The dynamic focus circuitry must be modified to increase the resolution capabilities at the edges of the raster. A vernier drive on the lens focus must be provided to maintain the optical resolution capabilities of the system. Tolerances on other optical and registration components must be reviewed and reworked where necessary to adequately meet the design goal.

Suppression of the raster lines in the monitors by increasing the number of lines in the raster is not recommended for this system due to the severe technical problems which would arise. Vertical spot wobble, however, will satisfy this need with no degradation of system resolution.

SECTION V - WORK STATEMENT

The following work items are proposed in order to meet the resolution requirement of 50 line pairs per millimeter for the change detector.

- 1. CIRCUIT DESIGN AND FOCUS IMPROVEMENT
 - This task will consist of a study and selection of a crt with a spot size of .0006 inch or less. In addition, the necessary circuitry for dynamic focusing will be developed.
- 2. RASTER LINE SUPPRESSION

A crt capable of spot wobble will be procured and the high frequency vertical sweep frequency will be developed. This will reduce the effect of raster lines in the monitor as described in Section III.

- 3. OPTO-MECHANICAL DESIGN IMPROVEMENT
 - This task will consist of general upgrading of the opto-mechanical elements used in the optical paths of the change detector. This will include improving of mechanical linkages and providing a vernier focus control.
- 4. FABRICATION

The above modifications will be integrated into the present change detector design and fabrication.

STATOTHR